



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

|  |  |   |
|--|--|---|
| (51) International Patent Classification <sup>6</sup> :<br><b>F01N 3/20, 3/28</b>  | <b>A1</b>  | (11) International Publication Number: <b>WO 95/18292</b><br>(43) International Publication Date: <b>6 July 1995 (06.07.95)</b> |
| <p>(21) International Application Number: <b>PCT/SE94/01238</b></p> <p>(22) International Filing Date: <b>22 December 1994 (22.12.94)</b></p> <p>(30) Priority Data:<br/><b>9304371-9 30 December 1993 (30.12.93) SE</b></p> <p>(71) Applicant (for all designated States except US): <b>AB VOLVO [SE/SE]; S-405 08 Göteborg (SE).</b></p> <p>(72) Inventors; and<br/>(75) Inventors/Applicants (for US only): <b>SMEDLER, Gudmund [SE/SE]; Bleket 101, S-440 64 Rönnäng (SE). LUNDGREN, Staffan [SE/SE]; Bandyvägen 8, S-430 63 Hindås (SE). JOBSON, Edward [SE/SE]; Jägarevägen 5, S-442 77 Rome-landa (SE). DEXELL, Björn [SE/SE]; Seglaregatan 22, S-414 57 Göteborg (SE). BACKLUND, Ove [SE/SE]; Ostron-gatan 25, S-414 57 Göteborg (SE).</b></p> <p>(74) Agents: <b>GRAUDUMS, Valdis et al.; Albihn West AB, P.O. Box 142, S-401 22 Göteborg (SE).</b></p>   | <p>(81) Designated States: <b>JP, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).</b></p> <p><b>Published</b><br/><i>With international search report.</i></p> |   |
| <p>(54) Title: <b>AN EXHAUST GAS PURIFICATION DEVICE</b></p> <div data-bbox="371 1131 1224 1356" data-label="Image"> </div> <p>(57) Abstract</p> <p>An exhaust gas purification device (10) for trapping combustion engine exhaust emissions, particularly hydrocarbons and particulate matter, is disclosed. The device includes a casing (12) having an inlet (14) for exhaust gases from a combustion engine. The casing (12) houses a filtering and/or adsorbing medium (16), whilst a catalytic converter (22) is arranged downstream of the medium (16). A valve arrangement is provided for controlling exhaust gas flow through the filtering and/or adsorbing medium (16). The casing further includes a throughflow passage (18) adjacent the filtering and/or adsorbing medium (16), the passage running from the upstream end to the downstream end of the filtering and/or adsorbing medium (16). The passage also includes a throttling valve (20) responsive to temperatures in the device.</p> |  |   |

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

|    |                          |    |                                       |    |                          |
|----|--------------------------|----|---------------------------------------|----|--------------------------|
| AT | Austria                  | GB | United Kingdom                        | MR | Mauritania               |
| AU | Australia                | GE | Georgia                               | MW | Malawi                   |
| BB | Barbados                 | GN | Guinea                                | NE | Niger                    |
| BE | Belgium                  | GR | Greece                                | NL | Netherlands              |
| BF | Burkina Faso             | HU | Hungary                               | NO | Norway                   |
| BG | Bulgaria                 | IE | Ireland                               | NZ | New Zealand              |
| BJ | Benin                    | IT | Italy                                 | PL | Poland                   |
| BR | Brazil                   | JP | Japan                                 | PT | Portugal                 |
| BY | Belarus                  | KE | Kenya                                 | RO | Romania                  |
| CA | Canada                   | KG | Kyrgyzstan                            | RU | Russian Federation       |
| CF | Central African Republic | KP | Democratic People's Republic of Korea | SD | Sudan                    |
| CG | Congo                    | KR | Republic of Korea                     | SE | Sweden                   |
| CH | Switzerland              | KZ | Kazakhstan                            | SI | Slovenia                 |
| CI | Côte d'Ivoire            | LI | Liechtenstein                         | SK | Slovakia                 |
| CM | Cameroon                 | LK | Sri Lanka                             | SN | Senegal                  |
| CN | China                    | LU | Luxembourg                            | TD | Chad                     |
| CS | Czechoslovakia           | LV | Latvia                                | TG | Togo                     |
| CZ | Czech Republic           | MC | Monaco                                | TJ | Tajikistan               |
| DE | Germany                  | MD | Republic of Moldova                   | TT | Trinidad and Tobago      |
| DK | Denmark                  | MG | Madagascar                            | UA | Ukraine                  |
| ES | Spain                    | ML | Mali                                  | US | United States of America |
| FI | Finland                  | MN | Mongolia                              | UZ | Uzbekistan               |
| FR | France                   |    |                                       | VN | Viet Nam                 |
| GA | Gabon                    |    |                                       |    |                          |

TITLE: An exhaust gas purification device

5

TECHNICAL FIELD:

The present invention relates to an exhaust gas purification device for trapping combustion engine exhaust emissions, particularly hydrocarbons and particulate matter, according to the preamble of claim 1.

10

BACKGROUND OF THE INVENTION:

For the last two decades, massive efforts have been made to reduce exhaust gas emissions as a result of increased environmental concern on the part of the general public and an increased knowledge concerning the harmful effects caused by the emissions. In terms of the otto-engine, replacement of carburettor systems by fuel injection technology and the first generation of catalytic converters was soon followed by three-way catalyst technology with closed-loop control of the air/fuel ratio. Despite the significant achievements provided by these technological milestones, even greater efforts will have to be made to satisfy more stringent forthcoming emission legislation.

15

20

25

30

35

One area in which improvement is needed is in cold-start emissions. The purification of toxic components in exhaust gases by catalysts is very much dependent on the temperature of the exhaust gas and when the exhaust gas temperature is low, for example immediately after cold start-up, hydrocarbons are hardly purified by the catalyst. Technical development for reducing cold start emissions from otto engines has resulted in a few promising approaches, for example the electrically heated catalyst (EHC) and the use of secondary air injection into the exhaust system. Cost and reliability aspects may, however, be limiting factors for the widespread adaption of these

concepts. In short, there is still a need for substantial improvement of cold start emissions from otto engines. The same is true for diesel and gas turbine engines.

5 Diesel engines have, in addition, the drawback of emitting particulates which are generally believed to play an important role as carriers of carcinogenic poly-aromatic hydrocarbons. Particulate emission reduction, therefore, has prime priority for diesel engine designers. Besides  
10 recent progress in diesel combustion technology, achieved by more accurate control of cylinder flow and fuel injection, a large number of systems have been developed to reduce the particulate emissions by aftertreatment systems, most commonly through trapping and burning the particulates  
15 in the exhaust system. In this case, it is absolutely essential that the burning, or regeneration, of the device that traps the particulates is carefully controlled. Otherwise, the latent heat of the particulates may well cause a virtual fire, yielding complete failure of the  
20 system. Therefore, inventions which make control of the regeneration procedure more robust are certainly needed.

Relatively recently, a new trend in cold start emission technology has gained momentum. This trend is based on the  
25 use of adsorbents to trap the cold start emissions at low exhaust gas temperature and to desorb them at higher temperature when the downstream catalytic converter has reached its operating (or light-off) temperature. Typical problems encountered for devices that use this principle  
30 include: i) difficulties in controlling the adsorption-/desorption phases precisely, ii) slower heating of the catalytic converter due to increased upstream thermal inertia, iii) parasitic power losses introduced by the increased flow resistance, and iv) the mechanical  
35 complexity of the device itself. The last class of problem is related to the first one, since the control of the

desorption process is often achieved by means of complete or partial bypassing of the device, introducing the inherent complexity of valve systems. An absorbent trapper and bypass arrangement is disclosed in EP-A-0 424 966 in which exhaust gases below a first temperature are passed through an absorbent trapper. When the exhaust gas temperature reaches the first temperature, a valve is activated to feed the exhaust gases through a conduit to bypass the trapper. When the exhaust gases reach a second, higher, temperature, the exhaust gases are again diverted through the trapper.

#### SUMMARY OF THE INVENTION:

It is therefore an object of the invention to provide an exhaust gas purification device for trapping exhaust emissions, particularly hydrocarbons and particulate matter, from combustion engines which is simpler and more efficient than known arrangements.

This object is achieved in accordance with the present invention by a device according to claim 1.

Since, in accordance with the invention, the throughflow passage is provided within the casing, a more compact arrangement is obtained. In addition, the proximity of the passage to the filtering and/or adsorbing medium provides effective heating of the medium.

Preferred embodiments of the invention are detailed in the dependent claims.

#### BRIEF DESCRIPTION OF THE DRAWINGS:

The invention will be described in greater detail in the following by way of example only and with reference to the attached drawings, in which:

Fig. 1 is a graph depicting a comparison of hydrocarbon concentrations in exhaust gases of an engine fitted with the device according to the invention and an engine without the device according to the invention;

Fig. 2 is a schematic partial sectional view of the device according to the invention in its cold start up mode, and

Fig. 3 is a schematic partial sectional view of the device according to the invention in its normal operating mode.

BEST MODE OF CARRYING OUT THE INVENTION:

The effectiveness of the device according to the invention which is described in the following is clearly illustrated in Fig. 1. In the shown example, a 2.3 litre Volvo petrol engine provided the cold start emissions. The upper line on the graph depicts the emissions from the engine without the device according to the invention being fitted, whilst the lower line shows the resulting cold start emissions when the device according to the invention is employed.

With reference to Figs. 2 and 3, reference numeral 10 generally denotes the exhaust gas purification device according to the invention. The device comprises a casing 12 having an inlet 14 for exhaust gases from a combustion engine (not shown). The casing 12 houses a filtering and/or adsorbing medium 16, with the medium presenting an upstream end 17 and a downstream end 19. The medium may consist of a packed bed of pelleted or granular material, a straight channel monolith, a ceramic foam or a honeycomb filter. The medium is provided with suitable agents to promote the filtering process. Such agents include zeolite, for example modernite, ceramic material such as cordierite, active

carbon, mullite or silicon carbide. The casing 12 further includes a throughflow passage 18 which, in accordance with the present invention, is positioned adjacent the filtering and/or adsorbing medium 16 and runs from the upstream end 17 to the downstream end 19 of the medium 16. The passage 18 cooperates with a throttling valve 20 responsive to temperatures in the device 10. The throttling valve 20 may be activated in a number of ways, for example using a solenoid actuator, a bimetallic (temperature-responding) device, a stepper motor or the likes. The throttling valve 20 may either be positioned within the passage 18 as illustrated in Figs. 2 and 3, or may be arranged at either end of the passage, preferably the downstream end, to thereby close off the passage when the valve 20 is in a closed position.

The device 10 also comprises a catalytic converter 22 arranged downstream of the filtering and/or adsorbing medium 16. As shown in the drawings, the catalytic converter 22 is advantageously housed within the casing 12. Preferably, the throttling valve 20 is responsive to the temperature of the downstream catalytic converter.

In a preferred embodiment of the invention, and as illustrated in the drawings, the casing 12 comprises an outer and an inner coaxial tube, with the inner coaxial tube forming the throughflow passage 18. The outer coaxial tube may be advantageously formed by the casing itself. Accordingly, an annular space is created between the inner tube (i.e. the throughflow passage 18) and the outer tube (i.e. the casing 12). This annular space is filled with the filtering and/or adsorbing medium 16.

As has been mentioned previously, at low exhaust gas temperatures hydrocarbons are hardly purified by the catalytic converter. In order to accelerate the warming up

of the downstream catalytic converter 22, in a preferred embodiment of the present invention a catalytic converter 24 is provided upstream of the filtering and/or adsorbing medium 16. For reasons which will become apparent from the following description of the mode of operation of the device according to the invention, the upstream catalytic converter 24 is preferably smaller than the downstream converter 22.

10 The device according to the invention operates in the following manner.

After cold start up, the exhaust gas flow which contains relatively high concentrations of harmful substances passes through the upstream catalytic converter 24. Thus, the upstream catalytic converter 24 is heated up whilst the exhaust gas flow is cooled. The exiting exhaust gas flow enters the casing 12. Since the downstream catalytic converter 22 is still cold, the throttling valve 20 in the through passage 18 is in its closed position as shown in Fig. 2. Thus, substantially the entire exhaust gas flow is directed through the filtering and/or adsorbing medium 16. The medium 16 effectively adsorbs the emission components in the cold exhaust flow. Thereafter, the cleansed exhaust gas flow passes through the cold downstream catalytic converter 22 and exits to atmosphere.

Due to its relatively small size, the upstream catalytic converter 24 quickly reaches its operative (light-off) temperature which is typically between 180 and 250°C. The temperature of the exiting exhaust gas flow thus rises rapidly and the downstream catalytic converter 22 begins to warm up. The increase in temperature of the downstream catalytic converter 22 causes the throttling valve 20 to open and, as a result of the much lower flow resistance through the throughflow passage 18 compared to the



corresponding flow resistance through the adsorbing medium, the majority of the hot exhaust gas flow passes directly to the downstream catalytic converter 22, which is thereby exposed to a hot flow of stoichiometric composition, i.e. to its ideal operating conditions. Meanwhile, the lesser volume of the exhaust gas flow, for example, 5 to 10%, passes through the annular space, thereby desorbing the emission components from the adsorber at a very slow rate. The emission components are thereafter mixed with the very much larger flow which comes directly from the upstream catalytic converter 24. This flow path is illustrated in Fig. 3.

Naturally, the present invention is not restricted to the embodiments described above and illustrated in the drawings but may instead be varied within the scope of the appended claims. For example, the casing 12 may be centrally divided so that the filtering and/or adsorbing medium 16 occupies one half of the cross section of the casing whilst the other half serves as the throughflow passage 18. Whilst the invention has been described in connection with a petrol engine, it is to be understood that it may also be advantageously employed on diesel and gas turbine engines. Due to the greater exhaust gas output of gas turbine engines, it will be apparent to the skilled person that the device according to the invention needs to be dimensioned accordingly.

## CLAIMS:

5

1. An exhaust gas purification device (10) for trapping combustion engine exhaust emissions, particularly hydrocarbons and particulate matter, said device comprising:

10 a casing (12) having an inlet (14) for exhaust gases from a combustion engine, said casing (12) housing a filtering and/or adsorbing medium (16), said medium presenting an upstream end (17) and a downstream end (19);

15 a catalytic converter (22) arranged downstream of said filtering and/or adsorbing medium (16), and

a valve arrangement responsive to temperatures in said device for controlling flow through said filtering and/or adsorbing medium (16);

20 c h a r a c t e r i z e d i n that said casing (12) further includes a throughflow passage (18) adjacent said filtering and/or adsorbing medium, said passage running from said upstream end to said downstream end of said filtering and/or adsorbing medium (16), and in that said valve arrangement comprises a throttling valve (20)  
25 arranged within or at either end of said throughflow passage (18).

2. The exhaust gas purification device as claimed in claim 1, c h a r a c t e r i z e d i n that said casing  
30 (12) comprises an outer and an inner coaxial tube, said inner coaxial tube forming said throughflow passage (18) and the annular space between said inner tube and said outer tube being filled with said filtering and/or  
adsorbing medium (16).

35

3. The exhaust gas purification device as claimed in claim 1 or 2, characterized in that said throttling valve (20) is responsive to the temperature of the downstream catalytic converter (22).

5

4. The exhaust gas purification device as claimed in any of the preceding claims, characterized in that a catalytic converter (24) is provided upstream of said filtering and/or adsorbing medium.

10

5. The exhaust gas purification device as claimed in claim 4, characterized in that said upstream catalytic converter (24) is smaller than said downstream catalytic converter (22).

15

6. The exhaust gas purification device as claimed in any of the preceding claims, characterized in that said downstream catalytic converter (22) is housed within said casing (12).

20

7. The exhaust gas purification device as claimed in any of the preceding claims, characterized in that when the temperature of said downstream catalytic converter (22) is below a predetermined value, the throttling valve (20) is closed so that the exhaust gas flow passes through said filtering and/or adsorbing medium (16).

25

8. The exhaust gas purification device as claimed in any of the preceding claims, characterized in that when the temperature of said downstream catalytic converter (22) is above a predetermined value, the throttling valve (20) is set to allow the majority of the exhaust gas flow to pass through the throughflow passage (18).

30  
35

10

9. The exhaust gas purification device as claimed in any of claims 4 to 8, characterized in that the exhaust gas flow passes through both catalytic converters at all times.

5

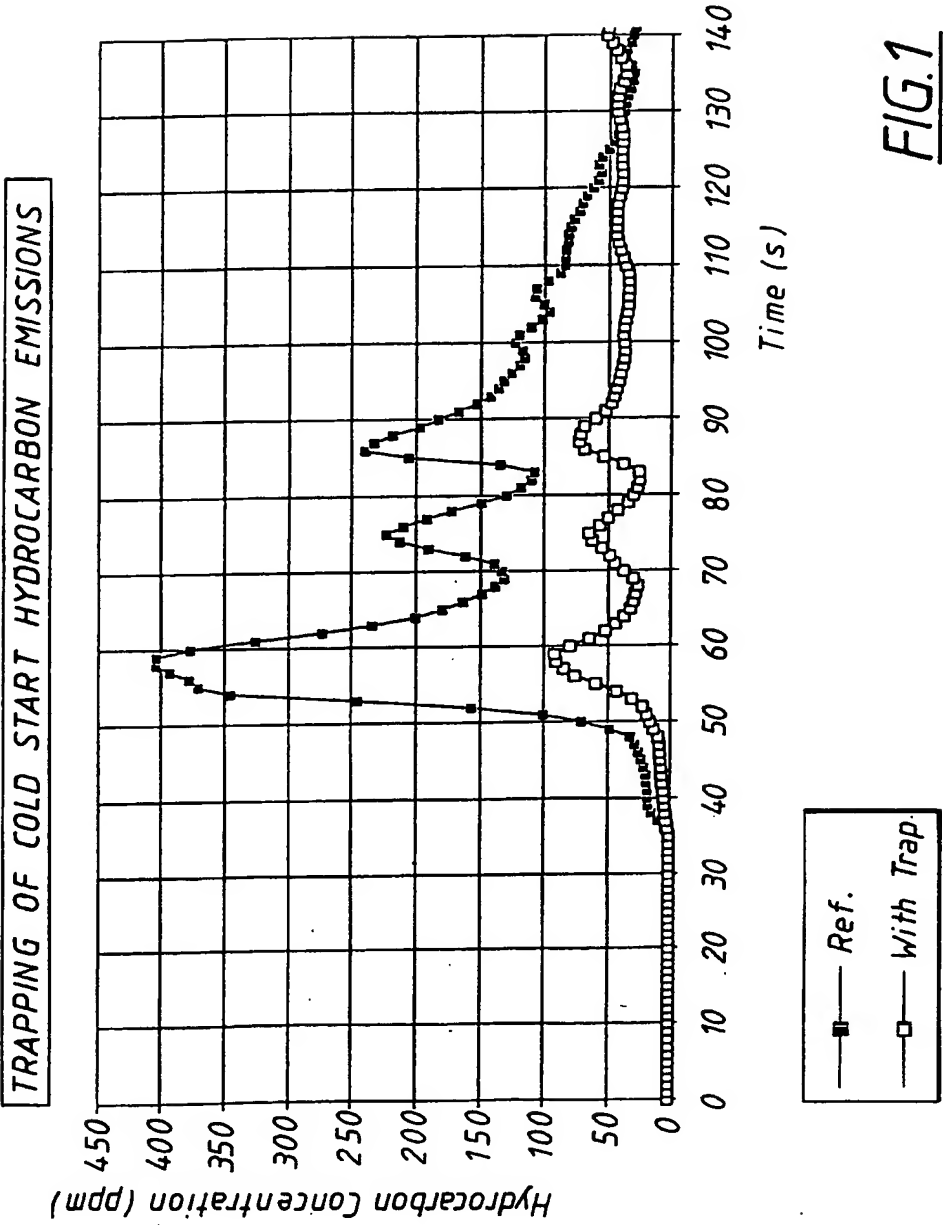


FIG.1

2/2

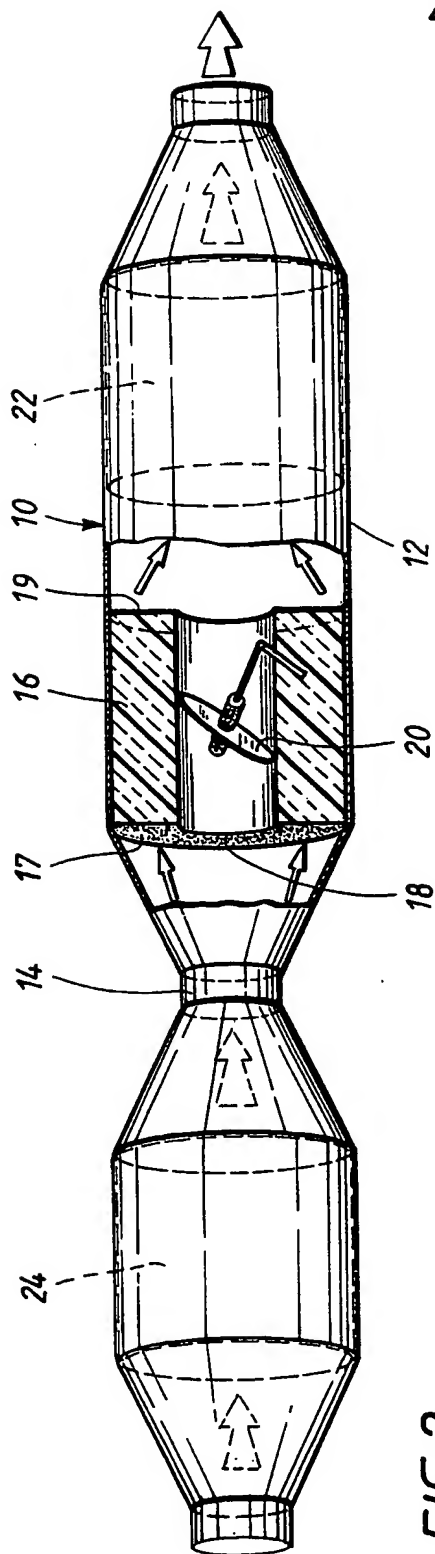


FIG. 2

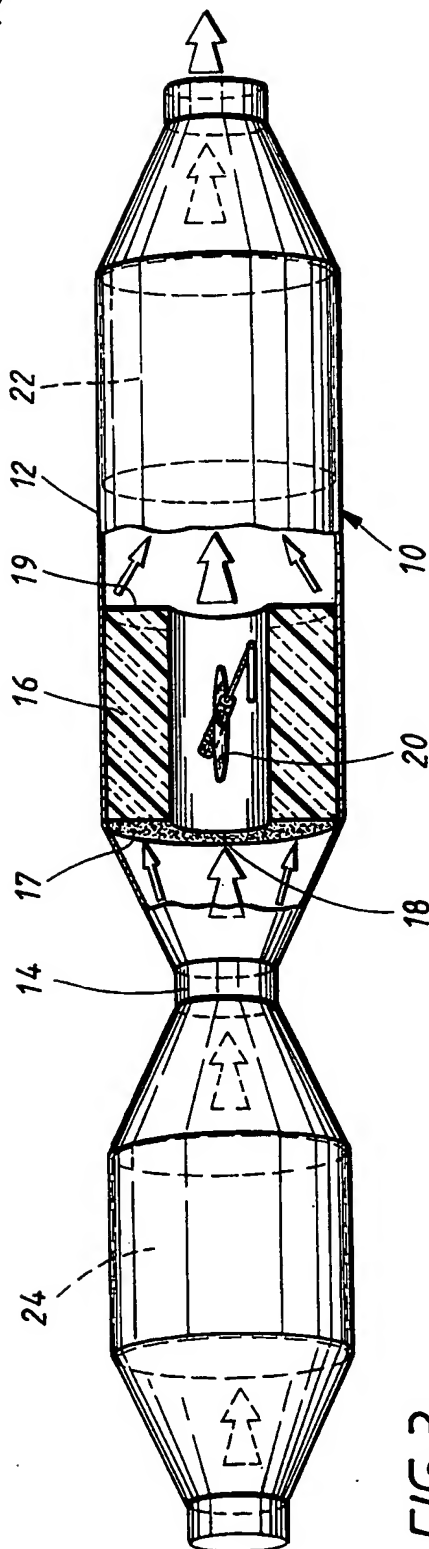


FIG. 3

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 94/01238

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: F01N 3/20, F01N 3/28

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: F01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages  | Relevant to claim No. |
|-----------|---|-----------------------|
| X         | US, A, 5067319 (FRANZ MOSER), 26 November 1991<br>(26.11.91), column 3, line 11 - line 60, figures 3, 4, claims 1-3<br>-- | 1,2                   |
| A         | SE, B, 468322 (ABVOLVO), 14 December 1992<br>(14.12.92)<br>--   | 1-9                   |
| A         | EP, A1, 0424966 (TOYOTA JIDOSHA KABUSHIKI KAISHA),<br>2 May 1991 (02.05.91)<br>--<br>-----                                | 1-9                   |

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family

Date of the actual completion of the international search

6 March 1995

Date of mailing of the international search report

'13 -04- 1995

Name and mailing address of the ISA/  
Swedish Patent Office  
Box 5055, S-102 42 STOCKHOLM  
Facsimile No. +46 8 666 02 86

Authorized officer

Johan von Döbeln  
Telephone No. +46 8 782 25 00

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

09/02/95

International application No.  
**PCT/SE 94/01238**

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s) | Publication<br>date |
|---|---------------------|----------------------------|---------------------|
| US-A- 5067319                             | 26/11/91            | DE-A, C- 4004424           | 16/08/90            |
| SE-B- 468322                              | 14/12/92            | SE-A- 9101750              | 17/10/92            |
| EP-A1- 0424966                            | 02/05/91            | DE-U- 6900111              | 22/04/93            |
|   |                     | JP-A- 3141816              | 17/06/91            |
|   |                     | US-A- 5140811              | 25/08/92            |